EXHIBIT "A"

INTEGRATED HERD MANAGEMENT UTILIZING ISOLATED POPULATIONS OF X-CHROMOSOME BEARING AND Y-CHROMOSOME BEARING SPERMATOZOA

I. TECHNICAL FIELD

Generally, herd management technologies utilizing isolated populations of X-chromosome bearing spermatozoa and Y-chromosome bearing spermatozoa that may be used with a variety of species of mammals. Specifically, an integrated bovine herd management system that utilizes isolated populations of X-chromosome bearing spermatozoa in a single-calf heifer system to increase the value of non-replacement heifers.

II. BACKGROUND

Economic pressures to improve beef cattle production efficiency have prompted the industry and researchers to evaluate various production systems. One conventional herd management system that has received considerable attention is the single-calf heifer system (SCH). This system has the capability to utilize non-replacement females normally targeted for slaughter. Simulated SCH systems compared to other beef management schemes using average costs of production and returns for products from 1958 to 1986 can be shown to be profitable. However, in order for a SCH system to remain economically sustainable, the end product must be acceptable to the consumer. The most essential component of the SCH system is that the heifer calve and be ready for harvest before she is 30 mo of age in order to avoid advanced carcass maturity.

Carcasses of advanced maturity pose problems in palatability, and therefore may be penalized by financial discounts. The USDA has set the approximate chronological age that corresponds to the physiological maturity score of "B" or greater to be 30 months of age or greater. However, maturity scores may increase with increasing chronological age at a much faster rate than USDA indicates and therefore suggested that animals 24 months of age and greater more accurately correspond to USDA maturity scores of "B" or greater. Therefore, to minimize risk of financial discounts and provide the consumer with a highly palatable product, target age of harvest for a SCH may be less than 24 months of age.

The SCH system can be designed to produce a carcass from the SCH as well as a calf. The carcass of the SCH must be of high quality but must not sacrifice the quality of the progeny. A production system in which a SCH is to rear a calf and be ready for harvest by 24 months of age, can possibly be accomplished by breeding the heifer at a non-traditional age of 9 months. Furthermore, it has been hypothesized that the younger the cow herd, the greater proportion of total feed used for weight production and a smaller amount of feed used for maintenance, lactation, gestation, and body condition score, hence increased biological efficiency.

It has also been hypothesized that if a SCH could produce only female calves, then only one parturition per female may be necessary and the dam could be slaughtered at a young enough age to still attain consumer acceptability without maturity discounts, thus creating a self-perpetuating herd system. Mating young cows to sexed-semen to yield female progeny may also reduce calving difficulties and increase calf survival.

To accomplish early breeding, induction of early puberty is necessary. Maturation into this state involves complex interactions between endocrine function, environment, social environment, breed, nutrition, and weight to bring about the development of reproductive tract and reproductive function. Diet is an effective tool to induce puberty. High-energy diets have been reported to induce onset of puberty in heifers at earlier ages than diets of lower energy. Weight of heifers tends to have a greater impact on puberty than age at puberty. Furthermore, heifers fed diets high in propionate production in the rumen reached puberty at lighter weights. Similarly, it has been found that diets containing ionophores decreased the age at onset of puberty, not related to ADG or body weight. Although plane of nutrition is inversely related to age at puberty, pattern of gain has no effect on age at puberty as long as heifers reach approximately 60-65% of mature body weight prior to breeding season. Hence, induction of early puberty depends on reaching target weights at a young age by feeding a feedlot-type diet high in energy and along with an ionophore. Early-weaning non-replacement heifers and managing them in feedlot conditions immediately following

PCT/US99/17165, hereby incorporated by reference.

As described above, in the context of beef cattle, upon weaning male animals (22) sold to the marketplace (20) can generate more revenue than female animals under identical herd management. Where the sex of the offspring mammals produced is substantially male animals, replacement animals (25) may have to be obtained from an external source (26). In some embodiments of the invention, 20% of the dams (17) are replaced each year once the herd is normalized.

Now referring to Figure 6, the invention can further comprise early weaning of male offspring (18) (or the desired sex ratio of offspring afforded by artificial insemination with populations of spermatozoa having known ratios of X-chromosome to Y-chromosome bearing spermatozoa). Understandable actual number of days to weaning of the offspring mammal can vary from species to species. Early weaning can be, with respect to beef cattle, as early as 95 days, or at an average age of about 110 days, or in certain embodiments of the invention between about 95 days to about 125 days. Additional embodiments of early weaned bovine mammal management are provided by Example 1 below.

Now referring to Figure 7, a generalized herd management invention is disclosed which can be used with a variety of species of mammals. The herd management invention utilizes isolated populations of X-chromosome bearing spermatozoa (some portion of the Y-chromosome bearing spermatozoa population has been removed to enrich the ratio of X-chromosome bearing spermatozoa to X-chromosome bearing spermatozoa in the total spermatozoa population). By utilizing isolated populations of X-chromosome bearing spermatozoa (as many as 98 of 100 spermatozoa bearing an X-chromosome) to artificially inseminate females (17) in the herd, female offspring can be produced to replace substantially all (or the number desired) of the females (17) harvested from the herd (20). As such, in certain embodiments of the invention each female (17) can have a single parturition prior to being harvested (20). The herd management invention can further comprise the practice of induced early puberty. Early puberty can be induced by generating rapid weight

gain in the mammal. As disclosed in further detail by Example 1, puberty can be induced in beef cattle as early as between about 250 days after birth to about 270 days after birth. A weight gain of about 1.3 kilograms per day to about 1.4 kilograms per day per head can be sufficient to induce early puberty. By inducing early puberty artificial insemination estrous synchronization (24) and artificial insemination (27) and can be performed at an earlier time in the herd management cycle. To further shorten the time between birth and harvest of the animal while allowing at least one parturition for replacement, the female mammal can be early weaned as described above. In a beef cattle embodiment of the invention a female can be born, weaned at between about 95 to about 125 days, estrous synchronized at between about 250 to about 280 days, artificially inseminated, calve about 9 months later and be harvested prior to 24 months.

While Figure 7, provides a specific time line for beef cattle embodiment of the herd management invention, it is understood that is illustrative of the broad variety of species of mammal that can be managed in a similar fashion and the specific example and time line provided is not intended to limit the invention to that specific example of that time line.

Now referring to Figure 8, an exemplary estrous synchronization protocol for beef cattle is provided in which cattle feed is top dressed with MGA at 0.5 milligrams per female animal per day for 14 days. On day 33, each female animal is injected with PGF2α. Three days subsequent, each female is artificially inseminated.

EXAMPLE 1

An integrated herd management system (IS) was designed to evaluate integration of early weaning and use of sexed semen in a single calf heifer (SCH) system to increase value of non-replacement heifers. The project consisted of five phases; Phases I, II, and III were developmental stages of the heifers. Phase IV was a qualitative measurement of the integrated system where carcass evaluation occurred. Phase V determined economic status of the integrated system. The integrated IS may be an alternative to the traditional marketing (TMS) of non-replacement heifers. Traditional marketing of non-replacement heifers is